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Nano fingerprints

Gathering intelligence

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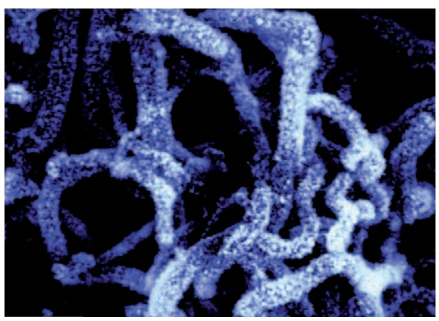
The use of powders to develop latent fingerprints left after criminal activity has been established for many years. However, various types of substrate surfaces, such as rough materials, fabrics, and adhesives are not well suited to this type of technique. Other methods have been developed, including acid dyes, cyanoacrylate fuming (CA), and the evaporation of metals such as gold, zinc, and silver. Protocol tables have been established that apply broad classifications to surfaces and outline appropriate development techniques.

Fingerprints are biochemically complex, containing fatty acids, glycerides, amino acids, and metal ions in various proportions, excreted from eccrine and sebaceous glands. Print composition also varies from person to person, and is strongly affected by factors such emotional state, grooming regime, and intake of food and drugs. This inter- and intra- donor variability further complicates detection and interpretation.

A US report in February 2009 outlined the need for additional and rigorous research on forensic techniques, and this was backed up by practitioners such as the chief forensic pathologist of the New York State Police, who stated in a *New Scientist* interview, "so many innocent people get convicted ... based on junk science"[1]. More recently, the UK Forensic Science Regulator has stressed the importance of ensuring the validity of methods, with peer-review and publication featuring as cornerstones of quality in forensic practice. This conclusion is reinforced by other studies and court actions that challenge the application and interpretation of fingerprint evidence. Therefore the development of a scientific understanding of forensic fingerprint evidence is both timely and critical in ensuring the continued trust in forensics and the validity of investigative methodology. Researchers across academia and the forensic provider sector have stepped up to the challenge, with recent advances in areas such as quantum dots for fingerprint development, detection of drug residues within fingerprint deposits, and statistical analysis and representation of uncertainties within the courtroom.

Research at Brunel University in London, in association with the UK Home Office, has been pioneering the use of micro and nanotechnological analysis to improve understanding of the operation and interaction of fingerprint development techniques. A recent study investigated titanium dioxide powders in suspension for developing fingerprints on adhesive tapes, for example from drug packaging[2]. This work demonstrated a nanoscale variation in particulate coating in commercial formulations that is responsible for the significant differences in the effectiveness of different powder suspensions. This also highlights a problem in detecting fingerprints: no one formulation is effective across all fingerprint donors, or on every material. Research on the surface interaction of development agents can



therefore help to improve development agent selection and hence enhance the detection process[3].

Multiple techniques can sometimes be utilized to aid development of fingermarks or obtain additional details, for example, when investigating fingermarks in blood[4]. However, the interaction of two techniques can sometimes be detrimental and obscure information from the fingerprint, therefore further elucidation of the operation of multiple techniques helps to ensure validity.

This month's cover image shows a back scattered electron micrograph of a fingermark developed with two sequential techniques. Here, vacuum metal deposition of gold and zinc, following cyanoacrylate development of a latent print leads to zinc nanoparticulate decoration of the polycyanoacrylate deposits[5]. The image was captured using a field emission scanning electron microscope, the contrast is dependent on atomic number. Operating in variable pressure mode enables imaging and analysis without the usual addition of a conducting coating.

There is more that a fingerprint could tell us. A wide consortium of research laboratories is investigating the potential to capitalize on the inter-donor variability of the biochemistry of fingerprints. Although a problem in developing prints and designing effective techniques, this variability may make it possible to gather extra intelligence about the victims or perpetrators of crime, such as age, gender, smoking, or drug habits, which could facilitate criminal investigations.

This work aims to improve the efficiency and performance of fingerprint detection, as well as aid the selection of the most appropriate development systems, and so facilitate enhanced and reliable collection of forensic information.

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